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SHORT REPORT

First description of post-fledging migration of Maltese Cory's Shearwaters *Calonectris diomedea diomedea*

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Three juvenile Cory's Shearwaters *Calonectris diomedea diomedea* were fitted with back-mounted satellite tags and tracked during post-fledging migration. The birds spent several weeks in the central Mediterranean before migrating westwards. Two tags stopped transmitting after 21 and 35 days; the third bird passed through the Strait of Gibraltar and along the West African coast until transmitting ceased after day 43, by which time it was 114.6 km off the coast and 4,390 km from Malta. Cory's Shearwaters from other Mediterranean islands winter further south in equatorial waters, in the eastern South Atlantic or in the northeast tropical Atlantic associated with the Canary current, and further research is needed to define the wintering areas of Maltese Cory's Shearwaters.

The Cory's Shearwater *Calonectris diomedea diomedea* is the most common breeding shearwater in Malta, with an estimated 4,340 to 4,860 breeding pairs (Raine *et al* 2009). Malta holds an estimated 5% of the Mediterranean population of this species (Sultana & Borg 2006), which is listed as 'Vulnerable' under the European IUCN Red List (BirdLife International 2004).

While this species has been studied extensively on land in Malta during the breeding season, little is known about its habits at sea. No information is available on post-fledging dispersal of juveniles, or the migratory patterns and wintering grounds of the Maltese population. There have been three international ring recoveries for this species related to Malta: (i) an adult ringed on Filfla Island, Malta, in June 1978 and recovered in March 1981 near Monastir, Tunisia, (ii) an adult ringed on Filfla Island in June 1977 and shot near Syracuse, Sicily, in March 1979 and (iii) a pullus ringed on Paximada Island, Crete, in August 1991 and recovered dead in March 2000 at Marsalforn Bay, Gozo. All of these recoveries were in March, when Cory's Shearwaters are returning to the Maltese islands for the start of the breeding season. As such, they provide no information on migratory patterns of the species after the breeding season or the location of their wintering grounds. Cory's Shearwaters breeding in the Mediterranean are known to pass in large numbers through the Strait of Gibraltar in October and November (Tellería 1980), and previous tagging work on adult Cory's Shearwaters breeding in Crete (Ristow *et al* 2000), the Balearic and Chafarinas Islands (González-Solís *et al* 2007) and Corsica (Office de l'Environnement de la Corse 2007) have shown that birds breeding in these areas winter in the Atlantic Ocean.

Three juvenile Cory's Shearwaters were fitted with Northstar Solar PTT satellite tags between 30 September and 12 October 2009. The birds came from two different breeding colonies located on the southwest coast of Malta: Ghar Lapsi (one bird) and Hal-Far (two birds). The devices were fitted to juvenile birds, just prior to fledging, using a thin, flexible plastic platform that was attached to the bird's back feathers with strips of duct tape. The tag was then mounted onto the platform using cable ties. Harnesses were not used, as they are in many other satellite-tagging studies, due to concern that the birds would become entangled in the harness when diving. Tags weighed approximately 13 g, with another 1 g for the base, glue and ties. This equated to approximately 1.7% of the birds' body weight, well within the limit recommended for tracking studies (Kenward 2001).

There had been some concern that there would be problems with downloading data from the satellite tags, particularly in Maltese waters. This is because there is a known problem in the region that is thought to emanate from two disruptive transmissions, one in the area around Italy and Sicily and one coming from Algeria (Gros & Malarde 2008). These transmissions are known to jam the frequency used by the Argos satellites,

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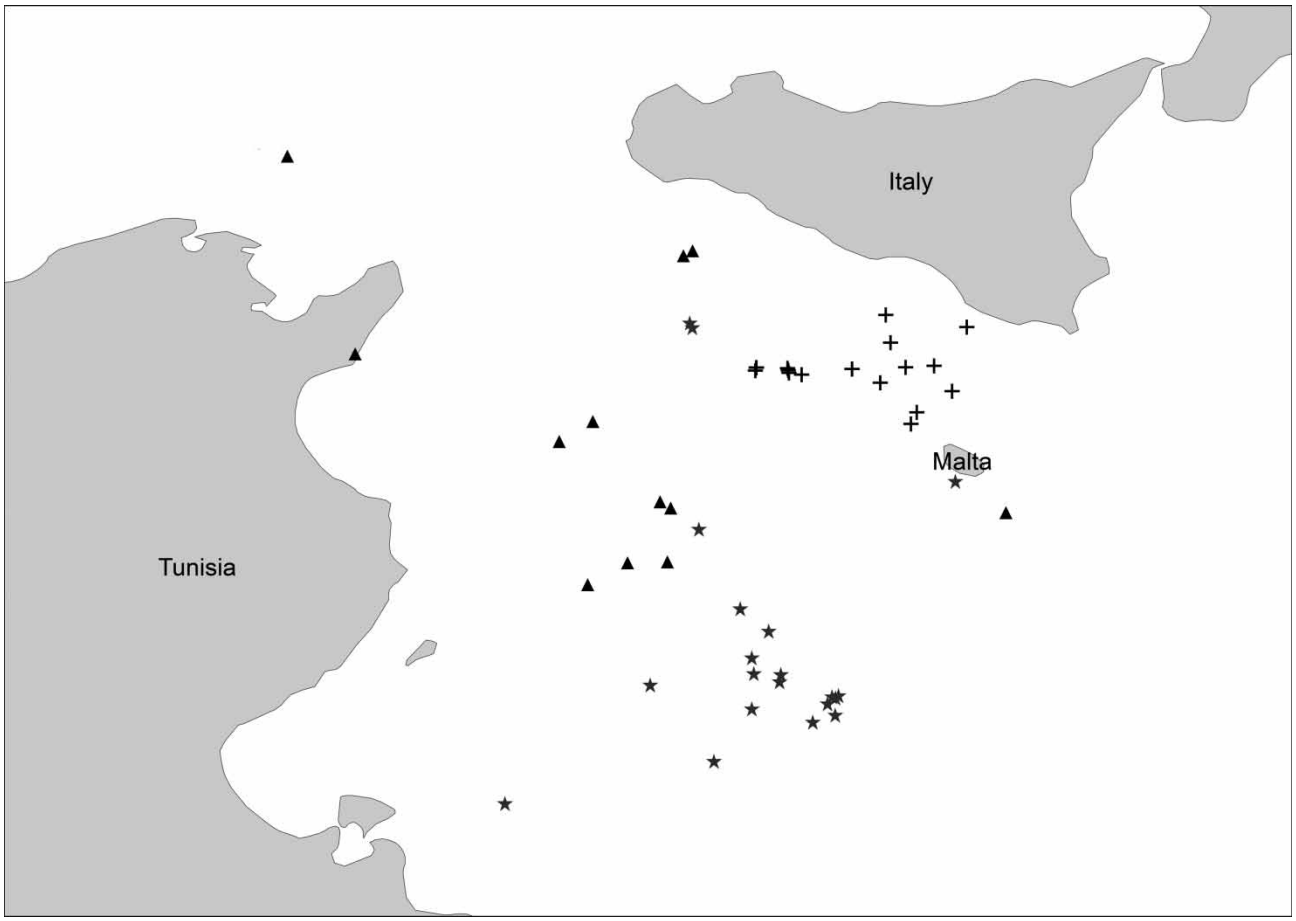

Figure 1. Locations of three juvenile Cory's Shearwaters in the three-week period after fledging – 90086 (circles), 90089 (stars) and 81040 (triangles).

thus preventing data download. Previous work on Yelkouan Shearwater *Puffinus yelkouan* in Malta had shown that, once tags were deployed, data did download, but at a low frequency and the data were often of low quality.

In total, 279 fixes were received from the three tagged birds over the course of the study. Of these, 155 (55.6%) were of a low quality (Argos Class: A, B or Z) and were thus excluded from further analysis. The remaining 124 fixes were of good quality (Argos Class: 0 – 3, with an accuracy of within 250 m for the highest-quality fixes). Transmission periods varied, with one tag (90086) transmitting for only 21 days, the second (90089) transmitting for 35 days and the third (81040) for 43 days. After these periods, it is assumed that the tags became detached.

All three birds spent the first few weeks after fledging in an area of sea between Malta, southern Sicily, the Pelagian Islands and northern Africa, with each bird using different areas within this part of the central Mediterranean (Fig 1). The tag 90086 transmitted for 21 days, throughout which period the bird remained in waters between Malta and southwestern Sicily. After 19 days and 27 days respectively, the two remaining birds headed westwards, passing the coasts of northern Tunisia and Algeria and heading for the Strait of Gibraltar. Transmissions ceased from the second tag (90089) 13 km off the North African coast near the border between Morocco and Algeria (Fig 2, grey stars). The remaining bird passed through the Strait of Gibraltar 30 days after fledging, on 13 November, and headed south, flying alongside the West African coast until its last transmission on 25 November (Fig 2, black triangles). At this point, the bird was 114.6 km off the coast at the border between Mauritania and Senegal, a distance of over 4,390 km from Malta.

The daily distance moved was not considered before the birds began migrating west, as they spent weeks moving about within the central Mediterranean. Taking Pantelleria Island as the limit after which western migration could be considered to have begun, the daily distance

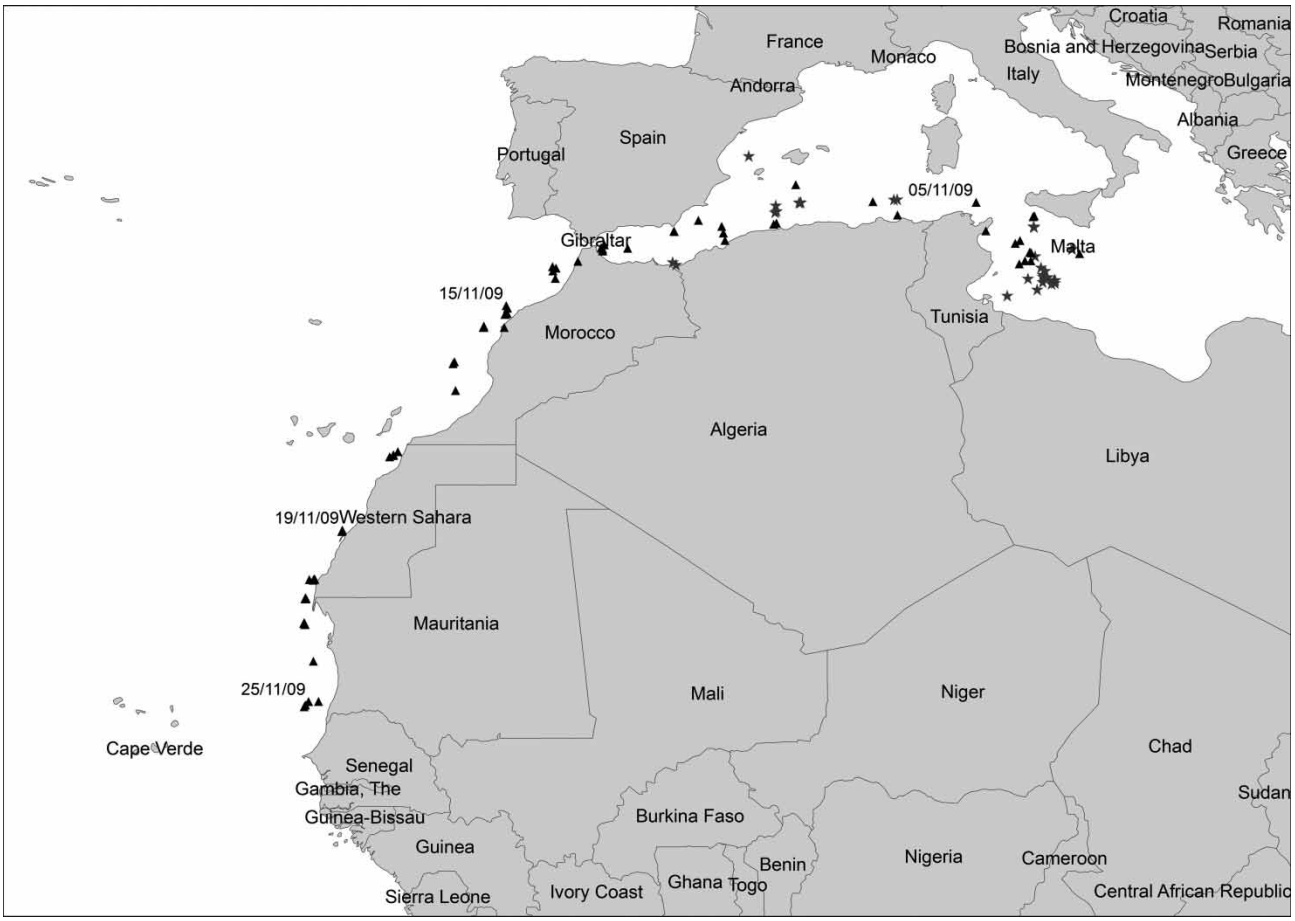

Figure 2. Migratory route of Cory's Shearwaters 90089 (grey stars) and 81040 (black triangles), over the duration of tag transmissions. A selection of dates is included for 81040 to indicate its direction and speed of travel.

travelled by birds 81040 and 90089 was analysed in each 24-hour period. During this time, 81040 travelled on average 219.7 km per day and 90089 an average of 256.0 km per day. Migration occurred only during daylight hours, with negligible movement at night when the birds were presumably rafting and moving slowly on ocean currents. A summary of data collected from each tag is presented in Table 1.

Our study has shown for the first time that Cory's Shearwaters fledging from Maltese breeding colonies may spend their first few weeks feeding in the central Mediterranean before beginning a westerly migration towards the Atlantic Ocean. They then pass through the Strait of Gibraltar and head in a southerly direction, remaining close to the African coast as they migrate. This migratory pattern should of course be considered with the proviso that only three birds were tagged, and further work is necessary to determine whether these movements are typical of the whole population.

Although the last transmission of the remaining shearwater came from the border between Mauritania and Senegal, it is uncertain whether the final wintering grounds for the Maltese population of this species are to be found in this area. The bird had been maintaining a near-constant speed until the point that its tag ceased transmissions, and it seems probable that it would have continued moving onwards from its final location. Three of four adult Cory's Shearwaters tracked from a breeding colony in Crete wintered further south, in equatorial waters (Ristow *et al* 2000), while adult Cory's Shearwaters tracked from the Balearic and Chafarinas Islands in the Mediterranean wintered in the eastern South Atlantic, associated with the Benguela Current, or in the northeast tropical Atlantic, associated with the Canary Current (González-Solís *et al* 2007). In the latter study, birds tagged in the Canary Islands and Azores wintered in the western South Atlantic off the coast of South America – wintering grounds also found for Manx Shearwaters

Table 1. Details of three juvenile Cory's Shearwaters tracked by satellite after fledging from their breeding colonies in Malta.

Tag number	90086	90089	81040
Colony	Hal Far 1	Ghar Lapsi	Hal Far 2
First fix	19 October	16 October	14 October
Last fix	8 November	19 November	25 November
No. days transmitting	21	35	43
No. good-quality fixes	18	32	74
Last transmission location	Northwest of Gozo	13 km off border of Morocco and Algeria	114 km off border of Mauritania and Senegal
Distance from colony (km)	48	1,580	4,390
Average speed on migration (km/day)	not known	256.0	219.7

Puffinus puffinus tracked from the UK (Guilford *et al* 2009). The Mediterranean subspecies of the Cory's Shearwater is also recorded in large numbers in winter off southern Africa (Camphuysen & Van Der Meer 2001). However, since all of these studies involved adult birds, there is no guarantee that young Cory's Shearwaters in their first winter utilise the same wintering grounds as adult birds.

It is evident that more work is necessary to continue mapping the migration patterns for Maltese populations of this species, as identifying the wintering grounds of these birds is a vital aspect of their conservation. Where, as in this case, the satellite tags are attached to the back feathers, the period during which data can be collected is fairly limited, as the tags eventually fall off from the pressure of repeated dives or after moult. Tags that can remain on the bird for the whole migration period are preferable. Ideally the next step will be to attach geolocators as, while these are less accurate, they have a much longer working life and can be retrieved in the following breeding season (in the case of adults) thus giving more information on the migratory patterns and wintering grounds of this species.

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